

Eternal 5D optical data storage in glass (Conference Presentation)

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ABSTRACT

A decade ago it has been discovered that during femtosecond laser writing self-organized subwavelength structures with record small features of 20 nm, could be created in the volume of silica glass. On the macroscopic scale the self-assembled nanostructure behaves as a uniaxial optical crystal with negative birefringence. The optical anisotropy, which results from the alignment of nano-platelets, referred to as form birefringence, is of the same order of magnitude as positive birefringence in crystalline quartz. The two independent parameters describing birefringence, the slow axis orientation (4th dimension) and the strength of retardance (5th dimension), are explored for the optical encoding of information in addition to three spatial coordinates. The slow axis orientation and the retardance are independently manipulated by the polarization and intensity of the femtosecond laser beam. The data optically encoded into five dimensions is successfully retrieved by quantitative birefringence measurements. The storage allows unprecedented parameters including hundreds of terabytes per disc data capacity and thermal stability up to 1000°. Even at elevated temperatures of 160°C, the extrapolated decay time of nanogratings is comparable with the age of the Universe - 13.8 billion years. The recording of the digital documents, which will survive the human race, including the eternal copies of Universal Declaration of Human Rights, Newton's Opticks, King James Bible and Magna Carta, is a vital step towards an eternal archive. Additionally, a number of projects (such as Time Capsule to Mars, MoonMail, and the Google Lunar XPRIZE) could benefit from the technique's extreme durability, which fulfills a crucial requirement for storage on the Moon or Mars.

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